

supply, controller, pulse generator, and pulse transmitter to generate the electrical pulses. In operation, the external pulse system 3130 sends electrical pulses to the stimulation apparatus 3100 via the connector 3132, the receptacle 3120, and the lead line 3124.

Figures 32 and 33 illustrate an embodiment of a stimulation apparatus 3200 for use with an external pulse system in accordance with another embodiment of the invention. Referring to Figure 33, the stimulation apparatus 3200 can include a support structure 3210 having a socket 3212, a plurality of contacts 3214 arranged in the socket 3212, and a diaphragm 3216 covering the socket 3212. The stimulation apparatus 3200 can also include a biasing element 3250 and a plurality of electrodes 3260 attached to the biasing element 3250. Each electrode 3260 is directly coupled to one of the contacts 3214 within the support structure 3210. It will be appreciated that an alternative embodiment of the stimulation apparatus 3200 does not include the biasing element 3250.

Referring to Figures 32 and 33 together, the stimulation apparatus 3200 receives the electrical pulses from an external pulse system 3230 that has a power supply, controller, pulse generator, and pulse transmitter. The external pulse system 3230 can also include a plug 3232 having a needle 3233 (Figure 33) and a plurality of contacts 3234 (Figure 33) arranged on the needle 3233 to contact the internal contacts 3214 in the socket 3212. In operation, the needle 3233 is inserted into the socket 3212 to engage the contacts 3234 with the contacts 3214, and then the pulse system 3230 is activated to transmit electrical pulses to the electrodes 3260.

Figures 34 and 35 illustrate additional embodiments of stimulation apparatus for use with external pulse systems. Figure 34 illustrates an embodiment of a stimulation apparatus 3400 having electrodes 3410 coupled to a lead line 3420 that extends under the scalp 702 of the patient 500. The lead line 3420 is coupled to an external pulse system 3450. Figure 35 illustrates an embodiment of a stimulation apparatus 3500 having a support member 3510, electrodes 3512 coupled to the support member 3510, and an external receptacle 3520 mounted on the scalp 702. The external receptacle 3520 can also be connected to the support member 3510. The

external receptacle 3520 can have a socket 3522 with contacts (not shown) electrically coupled to the electrodes 3512. The stimulation apparatus 3500 can be used with the external pulse system 3130 described above with reference to Figure 31 by inserting the plug 3132 into the socket 3522 until the contacts 3134 on the plug 3132 engage the contacts within the socket 3522.

6. Alternate Embodiments of Implantable Stimulation Apparatus

Figure 36 is a schematic cross-sectional view of an implantable stimulation apparatus 3600 in accordance with another embodiment of the invention.

In one embodiment, the stimulation apparatus 3600 has a support structure 3610 and a plurality of electrodes 3620 coupled to the support structure 3610. The support structure 3610 can be configured to be implanted under the skull 700 between an interior surface 701 of the skull 700 and the pial surface of the brain. The support structure 3610 can be a flexible or compressible body such that the electrodes 3620 contact the pia mater 708 when the stimulation apparatus 3600 is implanted under the skull 700. In other embodiments, the support structure 3610 can position the electrodes 3620 so that they are proximate to, but not touching, the pia mater 708.

In one embodiment, the stimulation apparatus 3600 can receive electrical pulses from an external controller 3630. For example, the external controller 3630 can be electrically coupled to the stimulation apparatus 3600 by a lead line 3632 that passes through a hole 711 in the skull 700. In an alternative embodiment, the stimulation apparatus 3600 can include an integrated pulse system similar to the pulse systems described above with reference to Figures 6-13. Such an embodiment of the stimulation apparatus 3600 can accordingly use a wireless external control unit. It will be appreciated that the electrodes 3620 of the stimulation apparatus 3600 can have several of the electrode configurations described above with reference to Figures 14-24.

Figures 37 and 38 illustrate one embodiment of the implantable stimulation apparatus 3600. Referring to Figure 37, the support structure 3610 can be